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(54) **Transmission power control for mobile radio using open and closed loop**

Übertragungsleistungsregelung für Mobilfunk unter Verwendung offener und geschlossener Schleife

Contrôle de puissance de transmission pour un radio mobile utilisant boucle ouverte et fermée

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Description

[0001] The present invention relates to a transmission power control method and a transmission power control apparatus using the same, and more particularly to a transmission power control method of a mobile station in a CDMA (Code Division Multiple Access) system which performs multiple access using a spread spectrum technique in mobile communications, and a transmission power control apparatus using this method.

[0002] As is well-known, a CDMA system falls into two classes: a direct sequence (DS) system which spreads a conventionally modulated signal by using a high rate spreading code; and a frequency hopping (FH) system which resolves a symbol into elements called chips, and translates each chip into signals of different center frequencies at a high rate. Since the FH system is difficult to implement in the state of the art, the DS system is usually employed. Spread-spectrum radio systems differ from conventional communication systems for satellite data networks such as SCPC/FDMA (Single Channel Per Carrier/Frequency Division Multiple Access) systems, or TDMA (Time Division Multiple Access) systems in that the spread-spectrum radio systems transmit, at a transmitter side, a signal after modulating it by a common modulation, and then, performing a secondary modulation using a spreading code to widen its signal bandwidth. At a receiver side, on the other hand, the wideband received signal is despread to restore the narrow band signal, followed by a conventional demodulation processing. The despreading is performed by detecting correlation between the spread-spectrum sequence of the received signal and a spreading code sequence which is generated at the receiving station, and peculiar to the channel. The capacity in terms of the number of subscribers in a cell is determined by an SIR (Signal-to-Interference Ratio) needed to achieve a required error rate because a CDMA system uses the same frequency band for the subscribers.

[0003] Applying the CDMA system to the mobile communications presents a problem in that received signal levels at a base station from respective mobile stations vary significantly depending on the locations of the mobile stations, and this arises a "near-far problem", in which a large power signal masks a small power signal, thereby reducing the number of mobile stations communicatable at the same time. In other words, a communication quality of a channel in the CDMA system is degraded by signals from other communicators because the same frequency band is shared by a plurality of communicators and the signals from the other communicators become an interference.

[0004] Fig. 1 illustrates an interference state in a reverse channel (from mobile station to base station) due to other mobile stations. When a mobile station MS1 closer to a base station communicates with the base station BS1 simultaneously with faraway mobile stations MS2 and MS3, the received power of the base station BS1 from the near mobile station MS1 will be greater than that from the faraway mobile stations MS2 and MS3. As a result, the communications of the faraway mobile stations MS2 and MS3 with the base station BS1 will be degraded owing to the interference from the near mobile station MS1.

[0005] To overcome such a near-far problem, transmission power control has been introduced. The transmission power control regulates received power at a receiving station, or the SIR determined by the received power, such that the received power or the SIR becomes constant regardless of the locations of mobile stations, thereby achieving uniform communication quality in a service area. Thus, the signal power from the other communicators becomes the interference, and hence, the transmission power control is essential to prevent the signal power of the other communicators from growing much larger than the transmission power of the intended channel.

[0006] In particular, with regard to a reverse channel, each mobile station must control its transmission power such that the received power thereof at a base station becomes constant. In a CDMA system, in which the interference power is considered as white noise, the transmission power error is the most important factor in determining the capacity in terms of the number of subscribers in a cell. For example, a 1 dB transmission power error will reduce the capacity in terms of the number of the subscribers by about 30%. Since an FDD (Frequency Division Duplex) system is generally employed to achieve two way communications, a reverse channel and a forward channel (from base station to mobile station) are frequency divided, that is, transmitted carrier frequency and a received carrier frequency differ from each other. Thus, a closed loop transmission power control is generally used in the FDD system.

[0007] Fig. 2 illustrates a method of determining transmission power of a mobile station with respect to a thermal noise level. In Fig. 2, the reference character S designates desired received signal power at a base station, I designates interference power at the base station, I_{max} designates maximum allowable interference power at the base station, which interference power depends on the system, and SNR designates a ratio of the desired received signal power S to the thermal noise power N at the base station. The transmission power control of a mobile station at the base station is performed as follows:

(1) The base station has set in advance a desired received signal level needed to achieve a satisfactory received quality of a signal from a mobile station.

(2) The base station measures the actual received signal level of the signal transmitted from the mobile station.

(3) The base station decides whether the actual received signal level of the signal from the mobile sta-

tion is greater or smaller than the desired received signal level.

(4) The base station inserts a transmission power control bit corresponding to the decision result periodically into a frame of a forward signal. The transmission power control bit commands an increase or a decrease of the transmission power of the mobile station.

[0008] This closed loop transmission power control makes it possible to carry out a high accuracy transmission power control whose error is within a few dB.

[0009] On the other hand, open loop transmission power control is performed as follows: First, the level of a signal transmitted from the base station is measured; and second, signal power transmitted from the mobile station to the base station is reduced when the received signal level at the mobile station is large, or vice versa.

[0010] Although the closed loop transmission power control is more accurate than the open loop transmission power control, the closed loop control involves a time delay. This is because the base station measures the received signal level from the mobile station, evaluates the transmission power of the mobile station of a few transmission power control intervals later, and then sets the transmission power of the mobile station using a forward transmission power control bit. Thus, proper transmission power control will be difficult owing to the time delay involved in the closed loop control when a sudden change in transmission characteristics occurs.

[0011] Furthermore, to absorb instantaneous fluctuations due to Rayleigh fading, the transmission power control bit must be inserted into frames at a rate higher than the Doppler frequency. For example, assuming that communications are carried out using carriers of 2 GHz band, and a mobile station is moving at 60 - 70 km/h, the Doppler frequency becomes about 200 Hz, and the received level will fluctuate at the interval corresponding to this frequency. Accordingly, the transmission power control bit must be inserted into frames at every few millisecond period. Considering the frame efficiency, the number of transmission power control bits per transmission power control must be limited to one or two. Hence, quick changes in the transmission power cannot be achieved by this number of bits.

[0012] On the other hand, since there are many high buildings in urban areas, the propagation path of a mobile station may suddenly transfers from a shadow of a high building to a line of sight area, or vice versa. In such cases, the received signal level at the base station can vary by more than 30 dB. As long as the transmission power control in the reverse direction operates normally as described above, the base station's received powers of the signals transmitted from respective mobile stations become constant, and hence, uniform receive quality can be obtained. However, when a mobile station suddenly moves out of the shadow of a building to a line of sight area, the base station's received power of the signal transmitted from the mobile station suddenly increases, and this induces large interference to signals transmitted from other mobile stations.

[0013] Fig. 3 illustrates an example of received signal level changes at the base station. In such cases, the closed loop transmission power control cannot quickly reduce the transmission power because the closed loop control involves some delay of a certain time constant. This presents a problem in that large interference to other users takes place.

[0014] As described above, the reverse transmission power control at a mobile station generally employs a closed loop transmission power control in the conventional CDMA system because high accuracy power control is required. The closed loop transmission power control, however, includes some delay of a considerable time constant involved in the feedback loop, and hence, it cannot achieve quick changes in the transmission power.

[0015] On the other hand, since there are many high buildings in urban areas, the propagation path of a mobile station may suddenly move from a shadow of a high building to a line of sight area, or vice versa. In such cases, the received signal level at the base station will vary by a large amount. In particular, when a mobile station suddenly moves out of a shadow of a building to a line of sight area, the base station's received power of the signal transmitted form the mobile station suddenly increases, and this presents a serious problem in that it provides large interference to signals transmitted from other mobile stations.

[0016] WO92/21196 discloses a transmission power control system for a CDMA cellular mobile telephone system in which the transmitted power is adjusted at the mobile unit in dependence upon a received signal power level and in dependence upon a received transmission control signal from a base station.

[0017] In a first aspect of the present invention, there is provided a transmission power control method of a CDMA (Code Division Multiple Access) system which controls transmission power of a mobile station on the basis of a transmission power control bit sent from a base station to the mobile station, the method comprising the steps of:

measuring, at the mobile station, average received power per transmission power control period of a signal sent from the base station;

detecting, at the mobile station, a power difference between the average received power of a current transmission power control period and that of one of previous transmission power control periods;

deciding, at the mobile station, whether the power difference exceeds a predetermined reference power difference;

setting, at the mobile station, transmission power of the mobile station in accordance with the power difference when the power difference exceeds the pre-

determined reference power difference, and in accordance with the transmission power control bit when the power difference is lower than the predetermined reference power difference.

[0018] The transmission power control method may further comprise the steps of:

calculating, at the base station, an SIR (Signal-to-Interference Ratio) of received power of a desired signal sent from the mobile station to a sum of interference power from other mobile stations and thermal noise power;
deciding whether the SIR is greater than a reference value predetermined for satisfying a predetermined transmission quality; and
inserting the transmission power control bit periodically into a forward (from base station to mobile station) frame in accordance with a result of decision at the preceding step of deciding.

[0019] In a second aspect of the present invention, there is provided a transmission power control apparatus for controlling transmission power of a mobile station in a code division multiple access system on the basis of a transmission power control bit sent from a base station to the mobile station, the apparatus comprising:

means for measuring, average received power per transmission power control period of a signal sent from the base station and received at the mobile station;
means for detecting a power difference between the average received power of a current transmission power control period and that of one of previous transmission power control periods;
means for deciding whether the power difference exceeds a predetermined reference power difference;
means for setting transmission power of the mobile station in accordance with the power difference when the power difference exceeds the predetermined reference power difference, and in accordance with the transmission power control bit when the-power difference is lower than the predetermined reference power difference.

[0020] A third aspect of the invention provides a transmission power control apparatus for use in a mobile station in a Code Division Multiple Access system, the apparatus being arranged to control the transmission power of said mobile station on the basis of a transmission power control bit received from a base station, the apparatus comprising:

means for measuring average received power per transmission power control period of a signal sent from the base station and received at the mobile station;
means for detecting a power difference between the average received power of a current transmission power control period and that of one of previous transmission power control periods;
means for deciding whether said power difference exceeds a predetermined reference power difference; and
means for setting transmission power of the mobile station in accordance with said power difference when said power difference exceeds said predetermined reference power difference, and in accordance with the transmission power control bit when said power difference is lower than the predetermined reference power difference.

[0021] A fourth aspect of the invention provides a transmission power control apparatus for use in a base station in a Code Division Multiple Access system, the apparatus being arranged to control the transmission of a transmission power control bit by the base station, the transmission power control bit being for use in controlling transmission power of a mobile station in the system including a transmission power control apparatus according to the third aspect of the invention, the apparatus comprising:

means for calculating an SIR (Signal-to-Interference Ratio) of received power of a desired signal sent from said mobile station and received at the base station to the sum of interference power from other mobile stations and thermal noise power;
means for deciding whether said SIR is greater than a reference value predetermined for satisfying a predetermined transmission quality; and
means for inserting said transmission power control bit periodically into a forward frame to be transmitted from said base station to said mobile station in accordance with the result of a decision by the means for deciding.

[0022] The transmission power control is performed by switching the closed loop control to the open loop control, or vice versa, in accordance with changes in the desired received signal level at the mobile station. More specifically, in an embodiment the transmission power of a mobile station is controlled at high accuracy by a closed loop control, and drops the transmission power of the mobile station quickly when the received signal power at the mobile station increases by a large amount in accordance with the state of neighboring buildings, thereby implementing the reverse direction transmission power control which can prevent interference to other mobile stations.

[0023] Embodiments of the present invention will now be described with reference to the accompanying drawings, in which:

Fig. 1 is a diagram illustrating interference from other mobile stations to a reverse channel in a conventional system;

Fig. 2 is a diagram illustrating a conventional transmission power control method with reference o a thermal noise level;

Fig. 3 is a diagram illustrating changes in received signal levels at a base station when a reverse link transmission power control is performed;

Fig. 4 is a flowchart illustrating a power control method in accordance with an embodiment of the present invention;

Fig. 5 is a diagram illustrating the operation of the power control method in accordance with an embodiment of the present invention;

Fig. 6 is a diagram illustrating the principle of the closed loop transmission power control in accordance with an embodiment of the present invention; and

Figs. 7A and 7B are block diagrams showing an embodiment of a mobile station of a CDMA system in accordance with an embodiment of the present invention.

[0024] An embodiment of the invention will now be described with reference to the accompanying drawings.

[0025] Fig. 4 is a flowchart showing a transmission power control in accordance with an embodiment of the present invention. A base station calculates at step S1 an SIR (signal-to-interference ratio) S/(I+N) of received power S of a desired signal from a party mobile station to the sum of interference power I from other mobile stations and thermal noise power N. Subsequently, the base station compares the received SIR with a predetermined reference SIR required for satisfying an intended transmission quality, and decides whether or not the received SIR is greater than the reference SIR. Then, the base station inserts a transmission power control bit periodically into information bits in a forward (from base station to mobile station) frame in accordance with the result of the decision (step S2).

[0026] Fig. 5 illustrates the operation principle of the transmission power control method at the mobile station in accordance with an embodiment of the present invention. In this figure, S denotes desired received signal power at the base station, I designates interference power at the base station, and SIR is a ratio of the desired received signal power S to the interference power I. The embodiment time-divisionally employs the closed loop control and the open loop control in accordance with changes in the desired received signal power at the mobile station.

[0027] The mobile station sequentially measures average received power per transmission power control period, of the desired signal transmitted from the base station. Thus, the mobile station calculates the average received power of the desired signal in the present transmission power control period and that in one or more previous transmission power control period, and then calculates the difference ΔRSSI of the two. If the average power difference ΔRSSI is lower than a predetermined reference power difference ΔP_{th} (step S3 in Fig. 4), the mobile station calculates its transmission power P_T in accordance with the transmission power control bit extracted from the forward frame at step S4 in Fig. 4. Thus, the transmission power of the mobile station is set by the closed loop transmission power control at step S4 of Fig. 4.

[0028] On the other hand, if the average power difference ΔRSSI exceeds the reference power difference ΔP_{th}, the mobile station quickly decreases its transmission power on the assumption that the mobile station moves out of the shadow of a building to a line of sight area. Specifically, the mobile station calculates the transmission power P_T at step S5 in accordance with the power difference ΔRSSI between the present transmission power control period and one of previous transmission power control periods.

[0029] This will be described in more detail referring to Fig. 5. As shown in Fig. 5, the desired received signal power S at the base station suddenly increases when the mobile station moves out of the shadow of a building to a line of sight area. This is because the mobile station is transmitting to the base station at the transmission power adjusted in the shadowed state, and hence, the received power at the base station increases to a much larger amount when the mobile station enters the line of sight area. In contrast, the interference power from other mobile stations will not change substantially. This results in an increase in interference to other mobile stations. To prevent such a problem, the embodiment tries to correct the interference in a very short time using the open loop control through steps S5, S6 and S8 of Fig. 4.

[0030] At step S6, the mobile station tests to decide whether the transmission power P_T calculated at steps S4 and S5 exceeds a predetermined maximum allowable transmission power P_{max}. If P_T does not exceed P_{max}, the mobile station carries out the transmission at the transmission power P_T at step S7, whereas if P_T exceeds P_{max}, it performs the transmission at the maximum allowable transmission power P_{max} at step S8.

[0031] The relation between the close loop control and the open loop control will be described in more detail. When the change ΔRSSI in the desired received signal power of the mobile station is less than the reference power difference ΔP_t, the mobile station performs a closed loop transmission power control as shown in Fig. 6.

[0032] In Fig. 6, the transmission power control is carried out as follows: (Numbers in brackets correspond to those of Fig. 6.)

[1] A base station measures a desired received power level, and calculates its SIR.

[2] The base station estimates a transmission power at two transmission power control periods later

by comparing the measured SIR with a predetermined reference SIR.

[3] The base station generates a transmission power control bit which commands an increment or decrement of transmission power of a mobile station, and inserts it into a forward frame periodically. The insertion period is determined such that the power control can follow instantaneous fluctuations associated with the Doppler frequency.

[4] The mobile station decodes the reverse link transmission power control bit, which is included in the forward frame sent from the base station.

[5] The mobile station transmits a signal at the transmission power commanded by the reverse link transmission power control bit included in the forward frame.

[0033] The reference power difference ΔP_{th} with respect to the change ΔRSSI in the desired received signal power is set as follows: First, a maximum value of decrement in the transmission power of the mobile station, which the transmission power bit or bits can provide during one or two frames in the closed loop control is estimated. Second, a value greater than the maximum value is set as the reference power difference ΔP_{th}, which is supposed to become about 30 - 50 dB in general.

[0034] Thus, the system can achieve high accuracy control because it primarily performs a closed loop transmission power control. Furthermore, since the closed loop control is switched to the open loop control that determines the transmission power P_T in accordance with the change ΔRSSI in the desired received signal power of the mobile station when the received signal power of the mobile station suddenly Increases owing to a propagation state surrounding the mobile station, the transmission power of the mobile station can be reduced In a very short time. Therefore, the interference to other communicators can be reduced.

[0035] Figs. 7A and 7B are block diagrams showing an embodiment of a CDMA mobile station In accordance with an embodiment of the present invention. A base station has a similar arrangement, but has no desired received power change detector 118.

[0036] The mobile station is roughly divided into a receiver block 102-126, and a transmitter block 130-140.

[0037] First, the receiver block will be described. The receiver block includes an RF downconverter 102 for converting an RF (Radio Frequency) received signal to an IF (Intermediate Frequency) signal. A forward signal, which is transmitted from the base station and received by the mobile station passes through the RF (Radio Frequency) downconverter 102, an AGC (Automatic Gain Control) amplifier 104, and a quadrature detector 106, and is inputted to a despreader 108. The despreader 108 Includes matched filters or a sliding correlator, and despreads the signal which has been spread by a PN (PseudoNoise) code. The output signal of the despreader 108 is supplied to a RAKE combiner and demodulator 110, a timing generator 114, a desired signal power detector 116, and an interference power detector 122.

[0038] The RAKE combiner and demodulator 110 performs demodulation of the signal, such as a reverse conversion of a signal which, for example, has undergone Walsh conversion, and combines individual chips of the signal by using the maximal-ratio combining. A frame separator 112 extracts a transmission power control bit from a symbol sequence of the forward signal thus combined. The timing generator 114 generates a timing signal for synchronization by detecting a pilot signal included in the forward signal, and feeds the timing signal to the desired signal power detector 116 and the interference power detector 122. The desired signal power detector 116 detects the power level of the intended received signal from the base station and performs a part of the processings of the foregoing steps S1 and S3 of Fig. 4. The desired signal received level is sent to a desired signal received power change detector 118 and a received SIR calculator 124.

[0039] The desired signal received power change detector 118 carries out the calculation and decision of the foregoing step S3 of Fig. 4 on the basis of the desired signal received level. The result of the decision is fed to a transmission power decision portion 120. The transmission power decision portion 120 receives the decision result from the detector 118 and the transmission power control bit from the frame separator 112, performs the processings of steps S4 - S8 of Fig. 4, and supplies a power amplifier 140 with a transmission power value obtained by the processings.

[0040] In connection with this, the base station performs a closed loop power control as follows:

First, a transmission power decision portion 120 of the base station calculates transmission power P_T based on a transmission power control bit supplied from a frame separator 112, and then outputs the upper limit power P_{max} when P_T exceeds P_{max}, and outputs P_T when P_T is lower than P_{max}.

[0041] In parallel with the above-described processings, the base station performs steps S1 and S2 of Fig. 4. First, an interference power detector 122 of the base station cooperates with a received SIR calculator 124 to perform the processing of step S1 of Fig. 4. The calculation result of the received SIR calculator 124 is sent to a control bit decision portion 126 of the base station which carries out the processing of step S2 of Fig. 4. The transmission power control bit determined by the control bit decision portion 126 is fed to a frame generator 130 which inserts the transmission power control bit to a frame to be transmitted to the mobile station Processings similar to steps S1 and S2 are also carried out at the mobile station.

[0042] Next, the transmitter block of the mobile station will be described. The frame generator 130 receives the

transmission power control bit, information data, pilot data, or the like, and generates a reverse frame (a frame sent from the mobile station to the base station) as shown in Fig. 6. The frame is fed to a spreader 132 which spectrum spreads the input signal by using the PN code generated by a spreading code generator 134. The signal spread by the spreader 132 undergoes a quadrature modulation by a modulator 136, and is inputted to the power amplifier 140 through an RF-upconverter 138. The power amplifier 140 amplifies the input signal up to the transmission power P_T or P_{max} determined by the transmission power decision portion 120, and transmits it.

[0043] Although the transmission power is controlled by the power amplifier 140 in the RF section at the mobile station it is controlled in the baseband using a current control at the base station. This is because the base station combines a plurality of channels at the baseband, and amplifies them at the same time.

[0044] The present invention has been described in detail with respect to an embodiment, and it will now be apparent from the foregoing to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects as defined in the appended claims.

Claims

1. A transmission power control method for a CDMA (Code Division Multiple Access) system which controls transmission power of a mobile station on the basis of a transmission power control bit sent from a base station to the mobile station, said method comprising the steps of:

   measuring, at the mobile station, average received power per transmission power control period of a signal sent from the base station;
   detecting, at the mobile station, a power difference between the average received power of a current transmission power control period and that of one of previous transmission power control periods;
   deciding, at the mobile station, whether said power difference exceeds a predetermined reference power difference;
   setting, at the mobile station, transmission power of the mobile station in accordance with said power difference when said power difference exceeds said predetermined reference power difference, and in accordance with the transmission power control bit when said power difference is lower than the predetermined reference power difference.

2. The transmission power control method as claimed in claim 1, further comprising the steps of:

   calculating, at the base station, an SIR (Signal-to-Interference Ratio) of received power of a desired signal sent from the mobile station to a sum of interference power from other mobile stations and thermal noise power;
   deciding whether said SIR is greater than a reference value predetermined for satisfying a predetermined transmission quality; and
   inserting said transmission power control bit periodically into a forward frame to be transmitted from said base station to said mobile station in accordance with a result of decision at the preceding step of deciding.

3. A transmission power control apparatus for use in a mobile station in a Code Division Multiple Access system, the apparatus being arranged to control the transmission power of said mobile station on the basis of a transmission power control bit received from a base station, the apparatus comprising:

   means (116) for measuring average received power per transmission power control period of a signal sent from the base station and received at the mobile station, the apparatus **characterised by** comprising:
   means (116) for detecting a power difference between the average received power of a current transmission power control period and that of one of previous transmission power control periods;
   means (118) for deciding whether said power difference exceeds a predetermined reference power difference; and
   means (120) for setting transmission power of the
   mobile station in accordance with said power difference
   when said power difference exceeds said predetermined reference power difference, and in accordance with the transmission power control bit when said power difference
   is lower than the predetermined reference power difference.

4. A transmission power control apparatus for use in a base station in a Code Division Multiple Access system, the apparatus being arranged to control the transmission of a transmission power control bit by the base station, the transmission power control bit being for use in controlling transmission power of a mobile station in the system including a transmission power control apparatus according to claim 3, the apparatus comprising:

   means (124) for calculating an SIR (Signal-to-Interference Ratio) of received power of a desired signal sent from said mobile station and

received at the base station to the sum of interference power from other mobile stations and thermal noise power, the apparatus **characterised by** comprising:
means (126) for deciding whether said SIR is greater than a reference value predetermined for satisfying a predetermined transmission quality; and
means (126) for inserting said transmission power control bit periodically into a forward frame to be transmitted from said base station to said mobile station in accordance with the result of a decision by the means for deciding (126).

Patentansprüche

1. Übertragungsleistungsregelungsverfahren für ein CDMA-(Kodemultiplex-) System, das eine Übertragungsleistung einer Mobilstation auf der Grundlage eines von einer Basisstation zu der Mobilstation gesendeten Übertragungsleistungsregelungsbits regelt, mit den Schritten

   Messen einer durchschnittlichen empfangenen Leistung pro Übertragungsleistungsregelungsperiode eines von der Basisstation gesendeten Signals an der Mobilstation,

   Erfassen einer Leistungsdifferenz zwischen der durchschnittlichen empfangenen Leistung einer aktuellen Übertragungsleistungsregelungsperiode und der einer Übertragungsleistungsregelungsperiode von vorhergehenden Übertragungsleistungsregelungsperioden an der Mobilstation,

   Entscheiden an der Mobilstation, ob die Leistungsdifferenz eine vorbestimmte Bezugsleistungsdifferenz überschreitet,

   Einstellen einer Übertragungsleistung der Mobilstation an der Mobilstation entsprechend der Leistungsdifferenz, wenn die Leistungsdifferenz die vorbestimmte Bezugsleistungsdifferenz überschreitet, und entsprechend dem Übertragungsleistungsregelungsbit, wenn die Leistungsdifferenz geringer als die vorbestimmte Bezugsleistungsdifferenz ist.

2. Übertragungsleistungsregelungsverfahren nach Anspruch 1, ferner mit den Schritten

   Berechnen eines SIR (Signal-zu-Interferenzverhältnisses) empfangener Leistung eines von der Mobilstation gesendeten gewünschten Signals an der Basisstation bezüglich einer Summe einer Interferenzleistung von anderen Mobilstationen und thermischer Rauschleistung,

   Entscheiden, ob das SIR größer als ein Bezugswert ist, der zur Erfüllung einer vorbestimmten Übertragungsqualität vorbestimmt ist, und

   periodisches Einfügen des Übertragungsleistungsregelungsbits in einen von der Basisstation zu der Mobilstation zu sendenden Vorwärtsrahmen entsprechend einem Ergebnis der Entscheidung im vorgehenden Entscheidungsschritt.

3. Übertragungsleistungsregelungsvorrichtung zur Verwendung in einer Mobilstation in einem Kodemultiplex-System, wobei die Vorrichtung zur Regelung der Übertragungsleistung der Mobilstation auf der Grundlage eines von einer Basisstation empfangenen Übertragungsleistungsregelungsbits eingerichtet ist, mit

   einer Einrichtung (116) zum Messen einer durchschnittlichen empfangenen Leistung pro Übertragungsleistungsregelungsperiode eines von der Basisstation gesendeten und an der Mobilstation empfangenen Signals,

   gekennzeichnet durch

   eine Einrichtung (116) zur Erfassung einer Leistungsdifferenz zwischen der durchschnittlichen empfangenen Leistung einer aktuellen Übertragungsleistungsregelungsperiode und der einer Übertragungsleistungsregelungsperiode vorhergehender Übertragungsleistungsregelungsperioden,

   eine Einrichtung (118) zur Entscheidung, ob die Leistungsdifferenz eine vorbestimmte Bezugsleistungsdifferenz überschreitet, und

   eine Einrichtung (120) zum Einstellen einer Übertragungsleistung der Mobilstation entsprechend der Leistungsdifferenz, wenn die Leistungsdifferenz die vorbestimmte Bezugsleistungsdifferenz überschreitet, und entsprechend dem Übertragungsleistungsregelungsbit, wenn die Leistungsdifferenz geringer als die vorbestimmte Bezugsleistungsdifferenz ist.

4. Übertragungsleistungsregelungsvorrichtung zur Verwendung in einer Basisstation in einem Kodemultiplex-System, wobei die Vorrichtung zur Regelung der Übertragung eines Übertragungsleistungsregelungsbits durch die Basisstation eingerichtet ist, wobei das Übertragungsleistungsregelungsbit bei der Regelung einer Übertragungsleistung einer Mobilstation im System verwendet wird, die eine Übertragungsleistungsregelungsvorrichtung nach Anspruch 3 aufweist, mit

   einer Einrichtung (124) zur Berechnung eines SIR (Signal-zu-Interferenzverhältnisses) empfangener Leistung eines von der Mobilstation gesendeten und an der Basisstation empfangenen gewünschten Signals bezüglich der Summe von Interferenzleistung von anderen Mobilstationen und thermischer Rauschleistung,

   gekennzeichnet durch

   eine Einrichtung (126) zur Entscheidung, ob das SIR größer als ein Bezugswert ist, der zur Erfüllung einer vorbestimmten Übertragungsqualität vorbestimmt ist, und

eine Einrichtung (126) zum Einfügen des Übertragungsleistungsregelungsbits periodisch in einen Vorwärtsrahmen, der von der Basisstation zur Mobilstation zu übertragen ist, entsprechend dem Ergebnis einer Entscheidung **durch** die Entscheidungseinrichtung (126).

Revendications

1. Procédé de commande de puissance d'émission pour un système CDMA (Accès Multiple par Répartition de Codes) qui commande la puissance d'émission d'une station mobile sur la base d'un bit de commande de puissance d'émission envoyé d'une station de base à la station mobile, le procédé comprenant les étapes consistant à:

   mesurer, dans la station mobile, la puissance moyenne reçue pendant une période de commande de puissance d'émission d'un signal envoyé par la station de base ;
   détecter, dans la station mobile, une différence de puissance entre la puissance moyenne reçue pendant une période de commande de puissance d'émission courante et celle de l'une de plusieurs périodes de commande de puissance d'émission précédentes ;
   décider, dans la station mobile, si oui ou non la différence de puissance dépasse une différence de puissance de référence déterminée à l'avance ;
   régler, dans la station mobile, la puissance d'émission de la station mobile en fonction de cette différence de puissance lorsque la différence de puissance dépasse la différence de puissance de référence déterminée à l'avance, et en conformité avec le bit de commande de puissance d'émission lorsque la différence de puissance est inférieure à la différence de puissance de référence déterminée à l'avance.

2. Procédé de commande de puissance d'émission suivant la revendication 1, comprenant en outre les étapes consistant à :

   calculer, dans la station de base, un rapport SIR (Rapport Signal-à-Brouillage) de la puissance reçue d'un signal souhaité envoyé par la station mobile à une somme de la puissance de brouillage due à d'autres stations mobiles et de la puissance de bruit thermique ;
   décider si oui ou non le rapport SIR est supérieur à une valeur de référence déterminée à l'avance pour satisfaire à une qualité d'émission déterminée à l'avance ; et
   insérer périodiquement le bit de commande de puissance d'émission dans une trame montante devant être émise par la station de base vers la station mobile en fonction d'un résultat de la décision prise lors de l'étape de décision précédente.

3. Appareil de commande de puissance d'émission destiné à être utilisé dans une station mobile dans un système à Accès Multiple par Répartition de Code, l'appareil étant conçu pour commander la puissance d'émission de la station mobile sur la base d'un bit de commande de puissance d'émission reçu d'une station de base, l'appareil comprenant :

   des moyens (116) pour mesurer la puissance moyenne reçue pendant une période de commande de puissance d'émission d'un signal envoyé par la station de base et reçu par la station mobile, l'appareil étant **caractérisé par le fait qu'**il comprend :

      des moyens (116) pour détecter une différence de puissance entre la puissance moyenne reçue pendant une période de commande de puissance d'émission courante et celle de l'une des périodes de commande de puissance d'émission précédentes ;
      des moyens (118) pour décider si oui ou non la différence de puissance dépasse une différence de puissance de référence déterminée à l'avance ; et
      des moyens (120) pour régler la puissance d'émission de la station mobile en fonction de la différence de puissance lorsque la différence de puissance dépasse la différence de puissance de référence déterminée à l'avance, et en fonction du bit de commande de puissance d'émission lorsque la différence de puissance est inférieure à la différence de puissance de référence déterminée à l'avance.

4. Appareil de commande de puissance d'émission destiné à être utilisé dans une station de base dans un système à Accès Multiple par Répartition de Code, l'appareil étant conçu pour commander l'émission d'un bit de commande de puissance d'émission par la station de base, le bit de commande de puissance d'émission étant destiné à être utilisé pour commander la puissance d'émission d'une station mobile dans le système comportant un appareil de commande de puissance d'émission suivant la revendication 3, l'appareil comprenant

   des moyens (124) destinés à calculer un rapport SIR (Rapport Signal-à-Brouillage) de la puissance reçue d'un signal souhaité envoyé par la station mobile et reçu par la station de

base, à la somme de la puissance de brouillage due à d'autres stations mobiles et de la puissance de bruit thermique, l'appareil étant **caractérisé par le fait qu**'il comprend

des moyens (126) destinés à décider si oui ou non le rapport SIR est supérieur à une valeur de référence déterminée à l'avance pour satisfaire à une qualité d'émission déterminée à l'avance ;

des moyens (126) pour insérer périodiquement le bit de commande de puissance d'émission dans une trame montante devant être émise par la station de base vers la station mobile en conformité avec le résultat d'une décision prise par le moyen de décision (126).

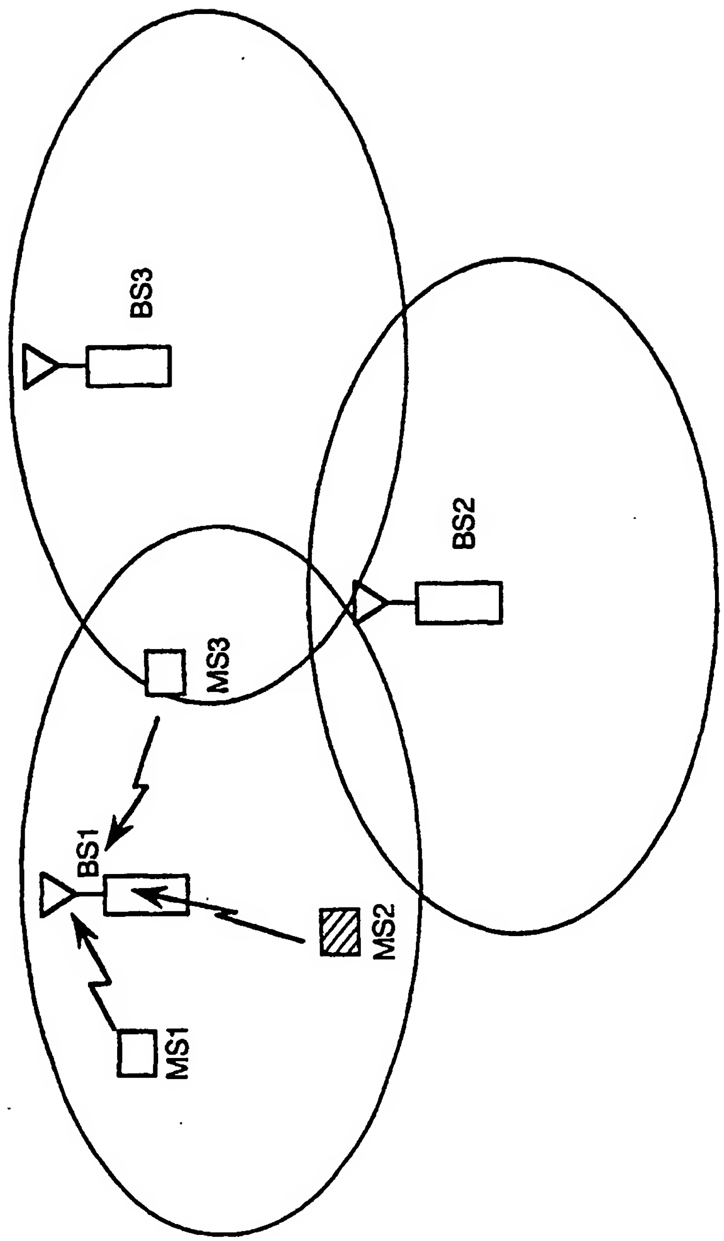

FIG.1

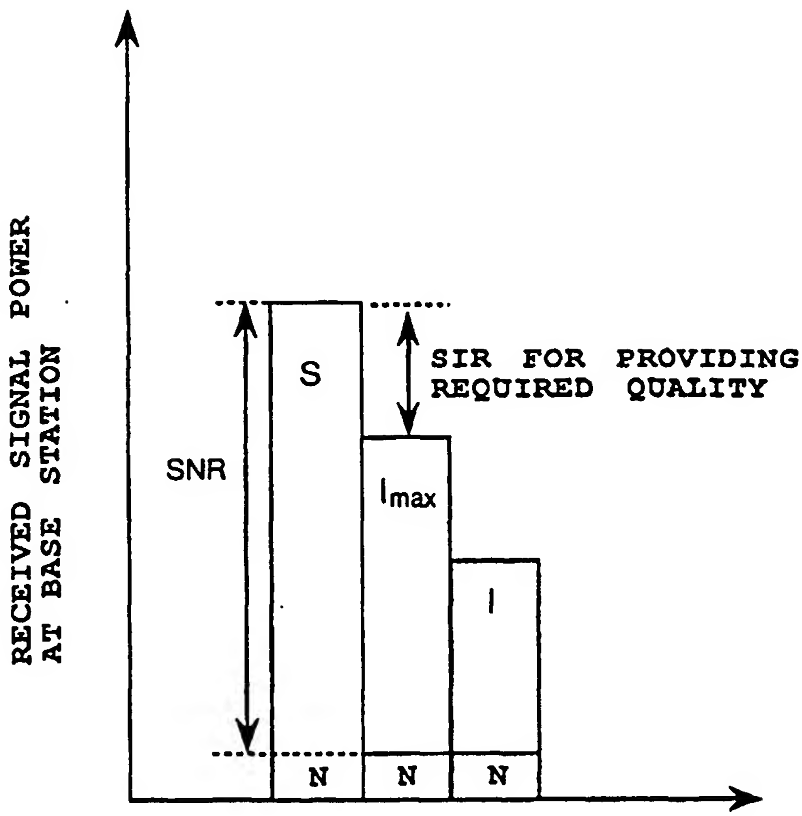
RECEIVED SIGNAL POWER AT BASE STATION
S
SNR
SIR FOR PROVIDING REQUIRED QUALITY
Imax
I
N
N
N

FIG.2

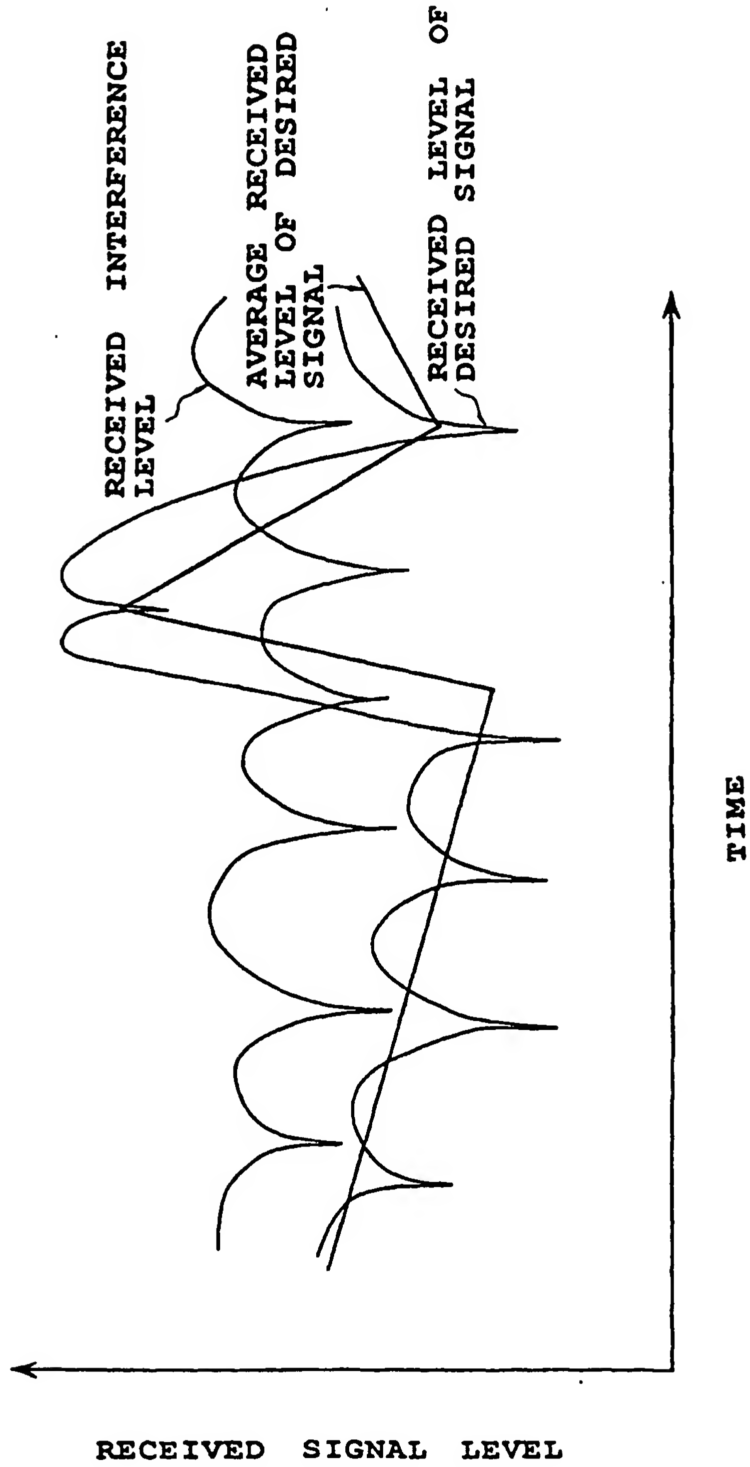
RECEIVED INTERFERENCE LEVEL
AVERAGE RECEIVED LEVEL OF DESIRED SIGNAL
RECEIVED LEVEL OF DESIRED SIGNAL
TIME
RECEIVED SIGNAL LEVEL

FIG.3

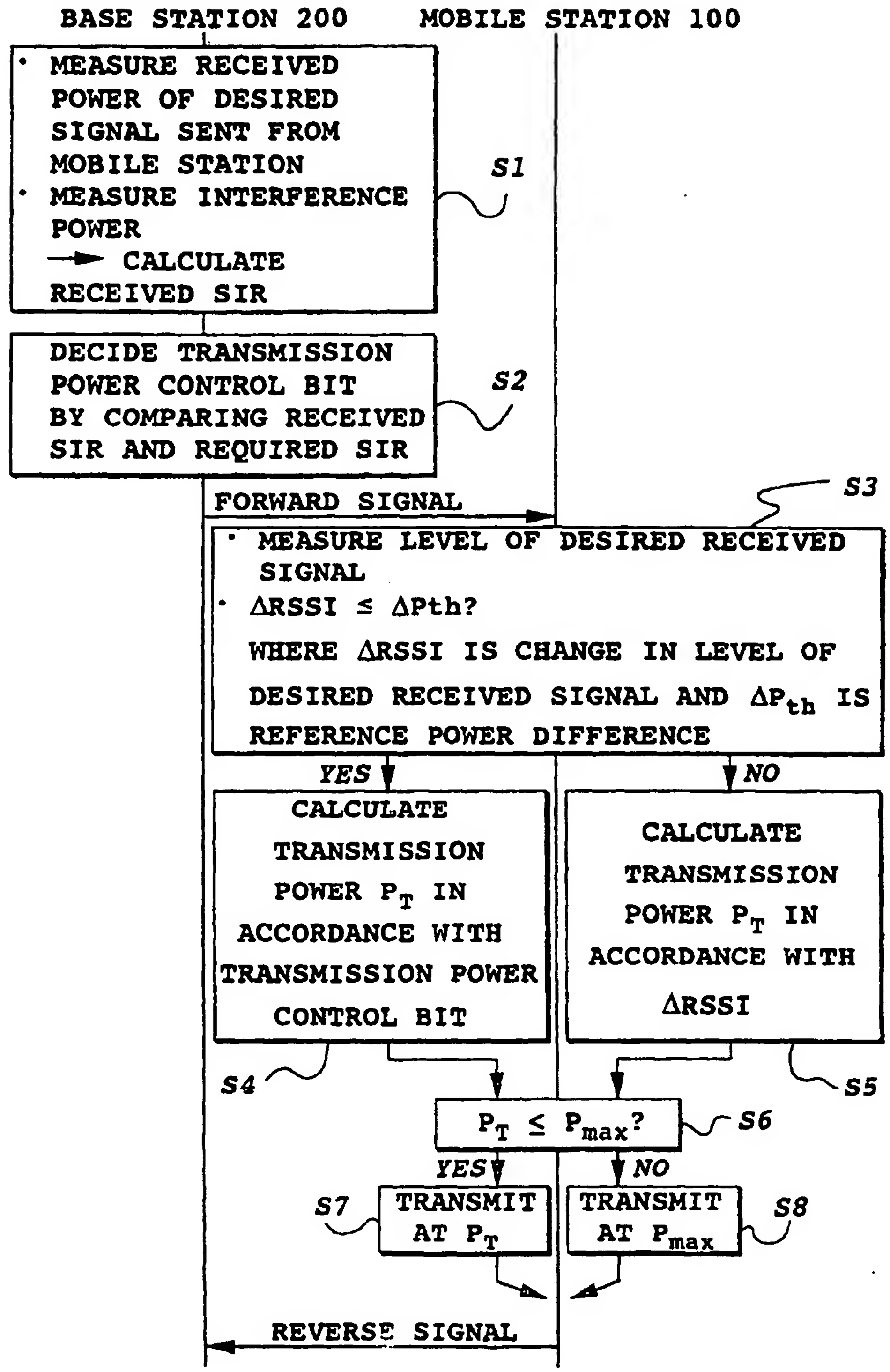
BASE STATION 200
MOBILE STATION 100
• MEASURE RECEIVED POWER OF DESIRED SIGNAL SENT FROM MOBILE STATION
• MEASURE INTERFERENCE POWER
→ CALCULATE RECEIVED SIR
S1
DECIDE TRANSMISSION POWER CONTROL BIT BY COMPARING RECEIVED SIR AND REQUIRED SIR
S2
FORWARD SIGNAL
S3
• MEASURE LEVEL OF DESIRED RECEIVED SIGNAL
• ΔRSSI ≤ ΔPth?
WHERE ΔRSSI IS CHANGE IN LEVEL OF DESIRED RECEIVED SIGNAL AND ΔP_{th} IS REFERENCE POWER DIFFERENCE
YES
NO
CALCULATE TRANSMISSION POWER P_T IN ACCORDANCE WITH TRANSMISSION POWER CONTROL BIT
CALCULATE TRANSMISSION POWER P_T IN ACCORDANCE WITH ΔRSSI
S4
S5
$P_T \leq P_{max}$?
S6
YES
NO
TRANSMIT AT P_T
TRANSMIT AT P_{max}
S7
S8
REVERSE SIGNAL

FIG.4

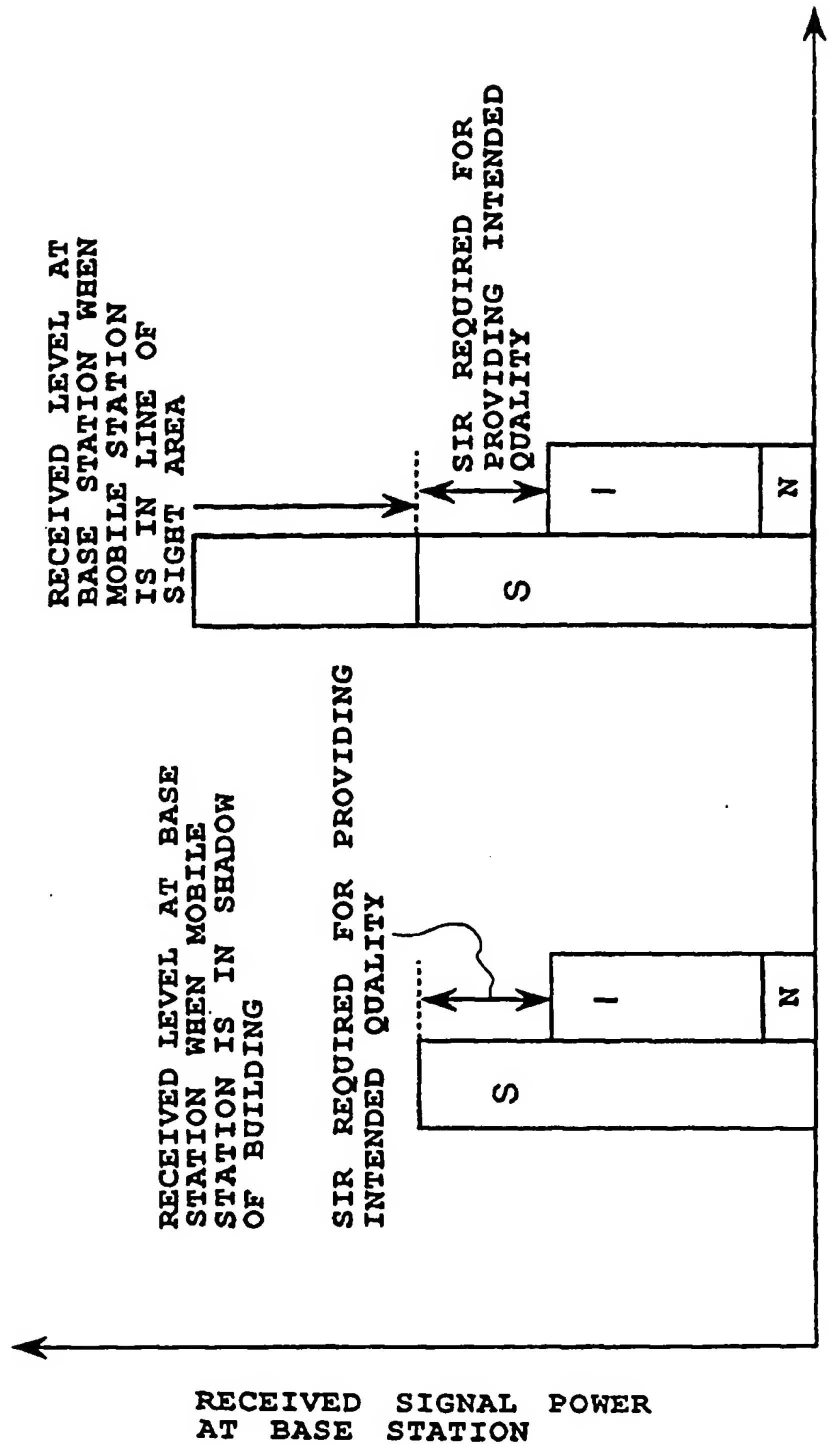
RECEIVED LEVEL AT BASE STATION WHEN MOBILE STATION IS IN LINE OF SIGHT AREA
SIR REQUIRED FOR PROVIDING INTENDED QUALITY
S
I
N
RECEIVED LEVEL AT BASE STATION WHEN MOBILE STATION IS IN SHADOW OF BUILDING
SIR REQUIRED FOR PROVIDING INTENDED QUALITY
S
I
N
RECEIVED SIGNAL POWER AT BASE STATION

FIG.5

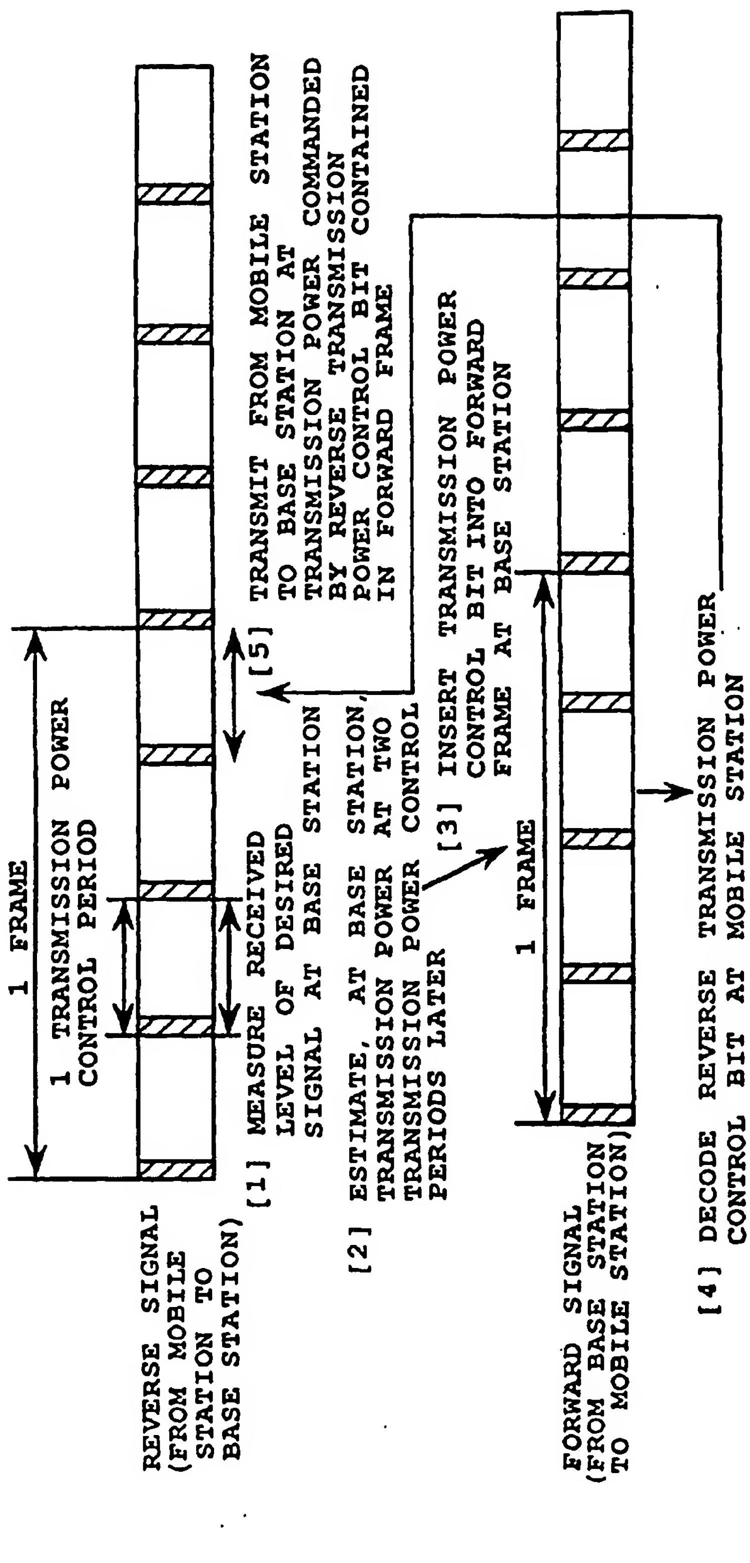
REVERSE SIGNAL (FROM MOBILE STATION TO BASE STATION)
1 FRAME
1 TRANSMISSION POWER CONTROL PERIOD
[1] MEASURE RECEIVED LEVEL OF DESIRED SIGNAL AT BASE STATION
[2] ESTIMATE, AT BASE STATION, TRANSMISSION POWER AT TWO TRANSMISSION POWER CONTROL PERIODS LATER
[3] INSERT TRANSMISSION POWER CONTROL BIT INTO FORWARD FRAME AT BASE STATION
[5] TRANSMIT FROM MOBILE STATION TO BASE STATION AT TRANSMISSION POWER COMMANDED BY REVERSE TRANSMISSION POWER CONTROL BIT CONTAINED IN FORWARD FRAME
1 FRAME
FORWARD SIGNAL (FROM BASE STATION TO MOBILE STATION)
[4] DECODE REVERSE TRANSMISSION POWER CONTROL BIT AT MOBILE STATION

FIG.6

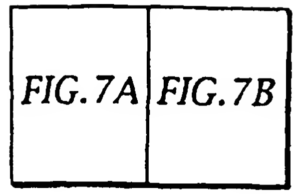
FIG.7A
FIG.7B

FIG.7

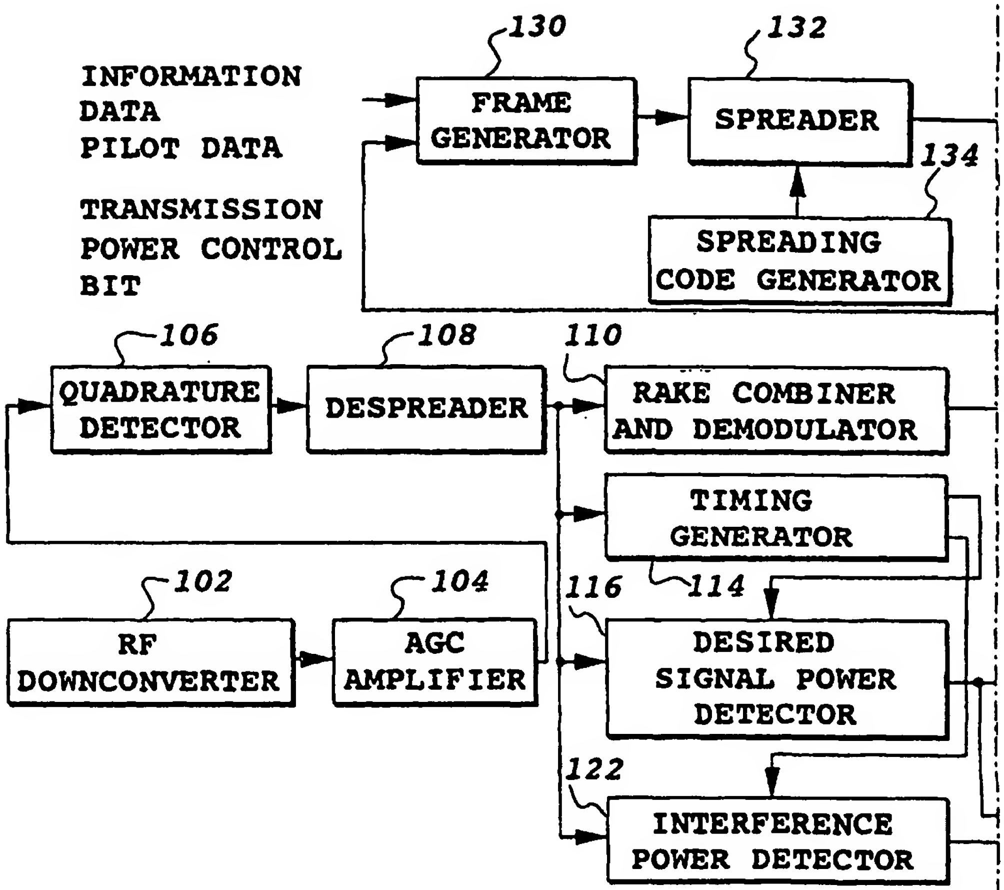
130
132
INFORMATION DATA
PILOT DATA
FRAME GENERATOR
SPREADER
134
TRANSMISSION POWER CONTROL BIT
SPREADING CODE GENERATOR
106
108
110
QUADRATURE DETECTOR
DESPREADER
RAKE COMBINER AND DEMODULATOR
TIMING GENERATOR
102
104
116
114
RF DOWNCONVERTER
AGC AMPLIFIER
DESIRED SIGNAL POWER DETECTOR
122
INTERFERENCE POWER DETECTOR

FIG.7A

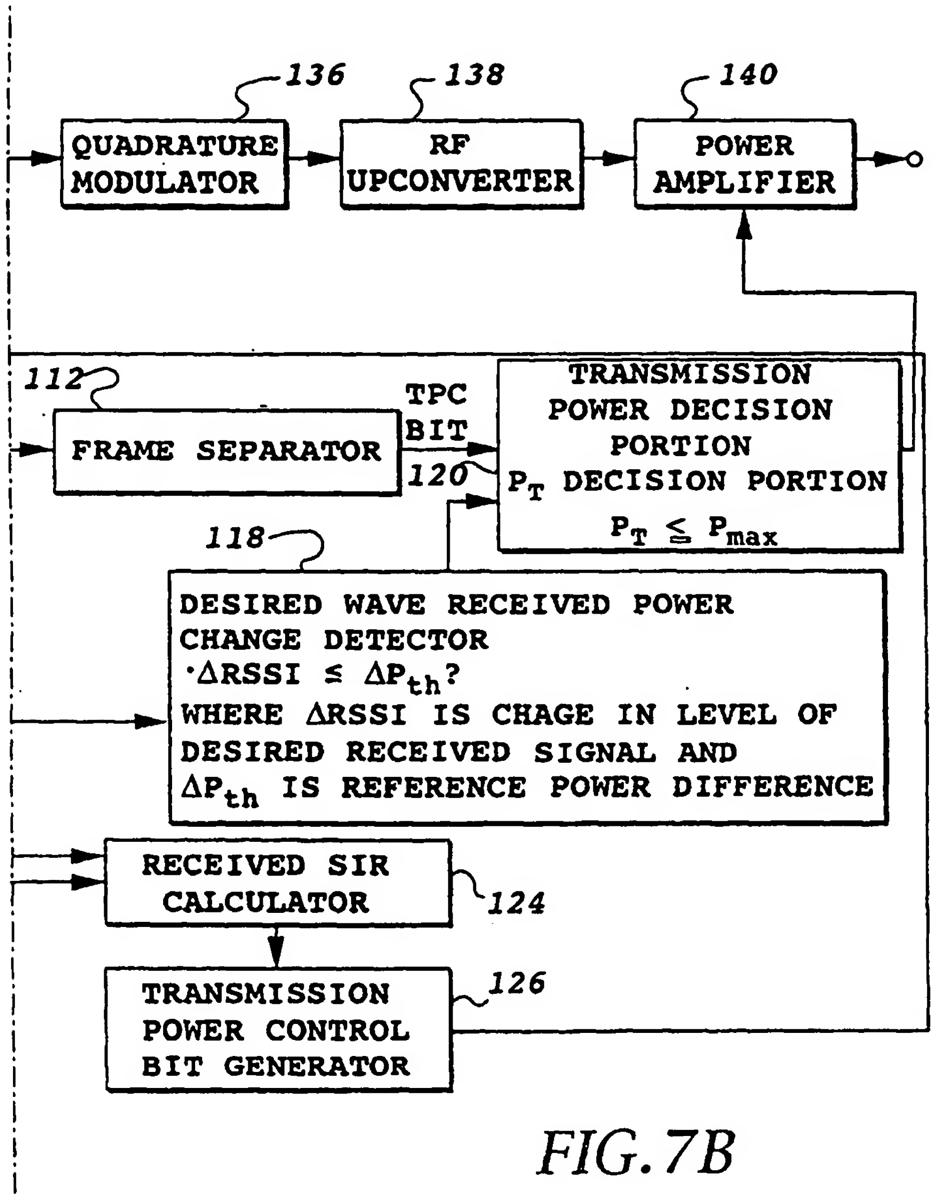
136
138
140
QUADRATURE MODULATOR
RF UPCONVERTER
POWER AMPLIFIER
112
TPC BIT
TRANSMISSION POWER DECISION PORTION
FRAME SEPARATOR
120
P_T DECISION PORTION
$P_T \leq P_{max}$
118
DESIRED WAVE RECEIVED POWER CHANGE DETECTOR
·ΔRSSI ≤ ΔP_{th}?
WHERE ΔRSSI IS CHAGE IN LEVEL OF DESIRED RECEIVED SIGNAL AND
ΔP_{th} IS REFERENCE POWER DIFFERENCE
RECEIVED SIR CALCULATOR
124
TRANSMISSION POWER CONTROL BIT GENERATOR
126

FIG. 7B